Joint Industry Program
on
Oil spill contingency for Arctic and ice-covered waters.

”JIP Oil in Ice”

October 2007

Stein Erik Sørstrøm
Program Coordinator
SINTEF

State-of-the-art study from 2005;

- Extensive research has been performed during the last 30 years including field tests, observations, laboratory studies and numerical studies to understand the fate, behaviour and weathering processes that take place when oil is spilled in ice.
- Despite some recent research, the majority of this work is however 10 years or older, as also concluded in a review on the behaviour of oil in freezing environments (Fingas and Hollebone, 2003).
- Some recent research;
  - MMS initiated in 2004 a three year research project focusing on fundamental weathering processes of oil in ice (spreading, evaporation, migration etc.).
  - Another ongoing program is performed by the University Centre on Svalbard (UNIS) and SINTEF regarding oil weathering at different ice conditions (Brandvik et al., 2005)
  - As well as the projects presented at this workshop
- Compared to the in-depth knowledge which exists regarding fate and behavior of oil spills in open water and temperate conditions our knowledge regarding Arctic oil spills are still limited.
- CONCLUSION
  - “A joint industry program on oil spill contingency for Arctic and ice covered waters” called “JIP Oil in ice”

Project managers

- Per Johan Brandvik, SINTEF
- Ivar Singsaas, SINTEF
- Per Daling, SINTEF
- Ian Buist, S L Ross Ltd
- Dave Dickins

Overall objective

Advance and develop

knowledge, methods and equipment

for oil spill response

in

Arctic and ice-covered waters.

Pre-project	Lab/basin/field experiments and tests	Full scale field trial	Conclusion

2005 — 2006 — 2007 — 2008 — 2009

Full scale field

Small scale field

Flume test

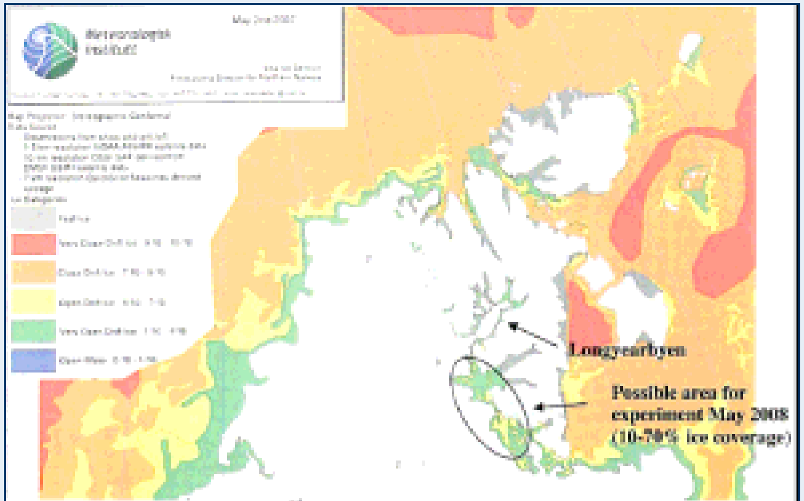
Large scale lab

Lab testing

Preparation

Large number — Promissing methods — New solutions

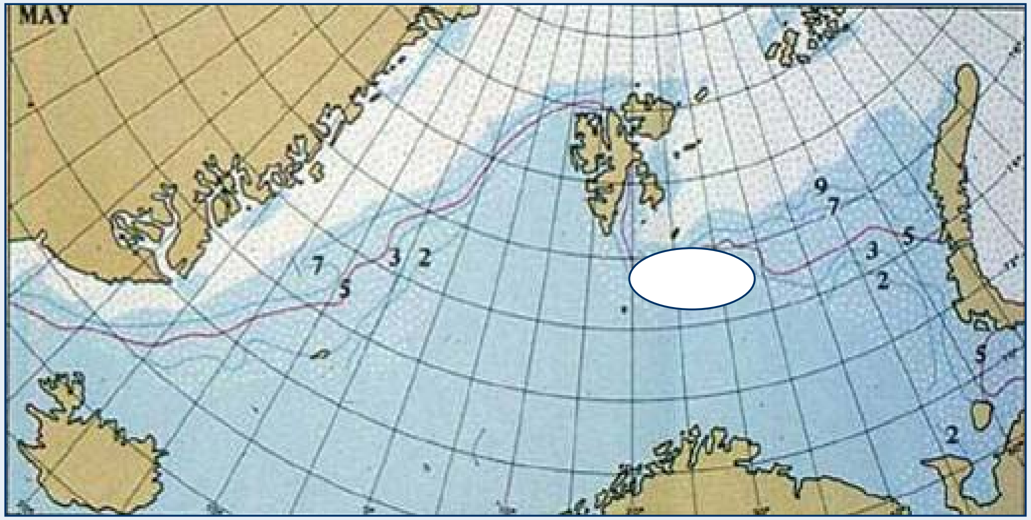
Field ex 2008



Ice-map for the Svalbard area, May 2nd 2007

P#	2008	Comments
P1 Weathering	Basic weathering data will be collected as support to the other projects (P2-P5)	
P2 Burning	Testing of herders and booms	Testing of herders require one separate or several small separate spills. Test of towing of booms in ice concentration less than 30% requires two vessels.
P3 Mechanical recovery	Testing of existing systems	Existing skimmer solutions modified for winter conditions A number of short term smaller spills (release and collect on the same day) and 1-2 tests pr skimmer.
P5. Remote sensing	Test of existing airborne systems operated by different coast guard organisations	The tests will be accomplished on the spills related to P2 and P3.

Field ex 2009



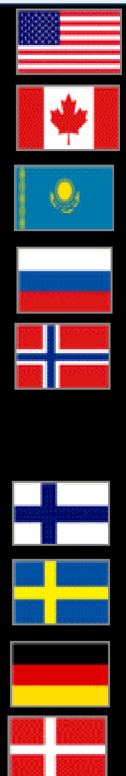
P#	2009	Comments
P1 Weathering	Original plan as scheduled.	Long-term weathering,10d, minimum 10m3. Preferably two spills and two different ice conditions (30-50% and 50-70%) 3-5 days. / 8-12 days.
P2 Burning	Large scale burn experiment.	60-70 % ice. Weather before burn. One separate burning experiment that requires a weathering period of approximately two days in advance. Separate spill. 1x10 m3 / 1 x5 m3 of basic crude.
P3 Mechanical recovery	Verification of 1-2 new concepts.	Two different ice-regimes. Separate spills based on emulsified oil.30-50 % ice. Separate vessel. 5 m3 pr small test. Short term experiments (release and collection on the same day). Separate vessels and separate crew. Sampling and analysis of oil on water.
P4. Dispersants	Testing of application systems.	Two separate spray tests. 6-12 hours / 1-3 days. Separate spills based on basic crude oil. 30-50% ice cover. 2 x 5 m3 pr spill. Dispersant application day one and after 1-3 days. Weathering before dispersant application. Directed by FLIR helicopter. Sampling of water column 2 days after dispersant application.
P5. Remote sensing	Verify / surveillance/ mapping of oil on water.	Airborne remote sensing equipment as a tool for mapping distribution of oil in ice as well as ice conditions. Required remote sensing systems to be decided.

Plus biological effects. P9- CRRC

Funders and participants

Oil Industri	R&D	Cooperating Organisations
Agip KCO	SINTEF	Oil Spill Recovery Institute
ConocoPhillips	In cooperation with	KYSTVERKET
Chevron	■SL Ross Ltd,	NOFO
Shell	■Dickins Associates	MMS
Total	and a number of other R&D organisations	ACS alaska clean seas
StatoilHydro		Coastal Response Research Center at the University of New Hampshire
BP		

IT'S INTERNATIONAL
Participants from 9 countries – and relevant for more than 20 Arctic regions

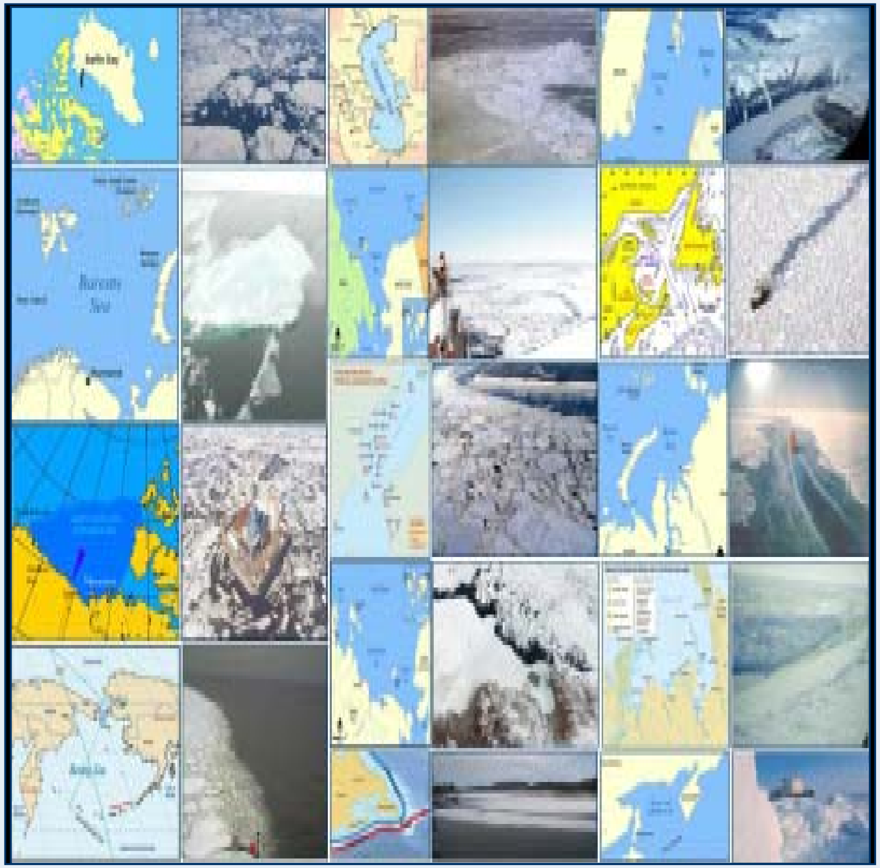


- USA
- Canada
- Kasaksthan
- Russia
- Norway

Oil producing

- Finland
- Sweden
- Germany
- Denmark

Tech + services



JIP Oil in ice

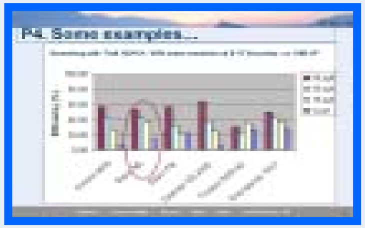
9 PROJECTS, 25 SUBPROJECTS,
approximately US$ 9-10 mill, 3,5 years from September 2006

- **P1 FATE AND BEHAVIOUR**
  - Compile existing data
  - Upgrade oil weathering model
  - Meso scale experiments
  - Field experiments on Svalbard
  - Full scale experiment

- **P2 IN SITU BURNING**
  - Mapping of burnability as a result of weathering
  - Field test of herding agents
  - Test fire resistant booms
  - Weathering and window of opportunity.

- **P3 MECHANICAL RECOVERY**
  - Test existing concepts – winterisation
  - Develope new concepts

- **P4 CHEMICAL DISPERSANTS**
  - Effectivness by use of dispersants
  - Improve application technology



- **P5 REMOTE SENSING**
  - Dev and test remote sensing systems
  - Shell methane detection system
  - Develop detection and tracking concept
  - Laser Fluorosensor system

- **P6 GENERIC OIL SPILL GUIDE**
  - Ice regimes (scenarios)
  - Generic plan
- **P7JIP COORDINATION**
  - Coordination and managment
  - Workshops and meetings
  - Communication

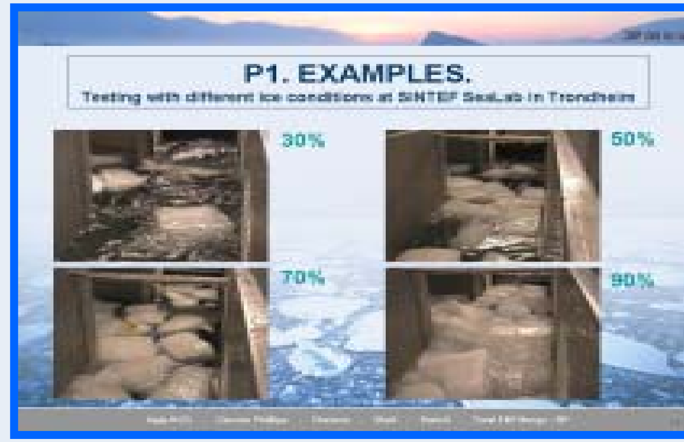
- **P8 FIELD EXPERPIMENTS**
  - Svalbard
  - Offshore field experiments
- **P9 BIOLOGICAL EFFECTS**
  - Oil-ice interaction vs biological effects

As much as 100 experts?

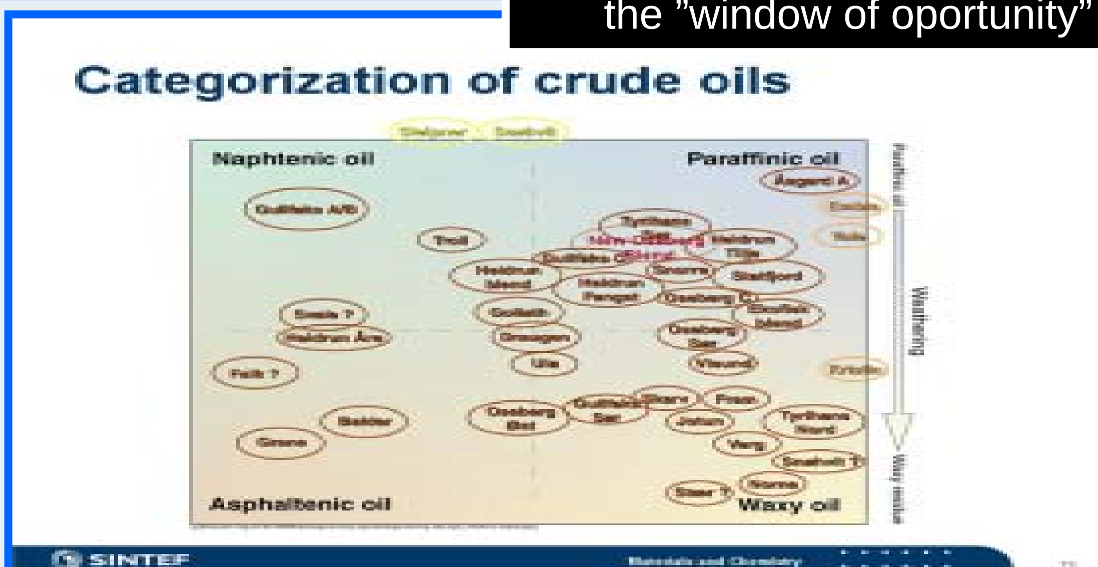
- **Steering Committee**
  - **Oil Companies**
    - **Agip KCO** Mark Shepherd
    - **Chevron Norge AS**, Gunnar H Lille
    - **Norske ConocoPhillips AS**, Eimund Garpestad
    - **Shell Technology Norway A/S**, Gina Ytteborg
    - **StatoilHydro** , Hanne Greiff Johnsen
    - **Total E&P Norge**, Ulf Einar Moltu
    - **BP;** Tad Lynch
  - Pluss a number of technicall experts in different topics
- **Program coordinator**
    - Stein E Sørstrøm, SINTEF

- **R&D Organisations**
    - **SINTEF**
    - **D. Dickins Associates**
    - **S L Ross**
    - **++++**
- **Cooperating Organisations**
    - **Norwegian Clean Seas, Hans V Jensen**
    - **Alaska Clean Seas, Lee Majors**
    - **Norw. Coastal Admin., Johan M. Ly**
    - **MMS, Joe Mullins/Dick Prentki**
    - **OSRI, Scott Pegau**
    - **CRRC/NOAA, Amy Merten**
    - **.. and a number of other experts**
- **Reference group on each project;**
    - **5 experts**
- **Total number of experts involved;**
    - **Approx 100**

P1 Behavior of oil in ice - weathering



Defining weathering properties is one important basis for defining the ”window of oportunity”



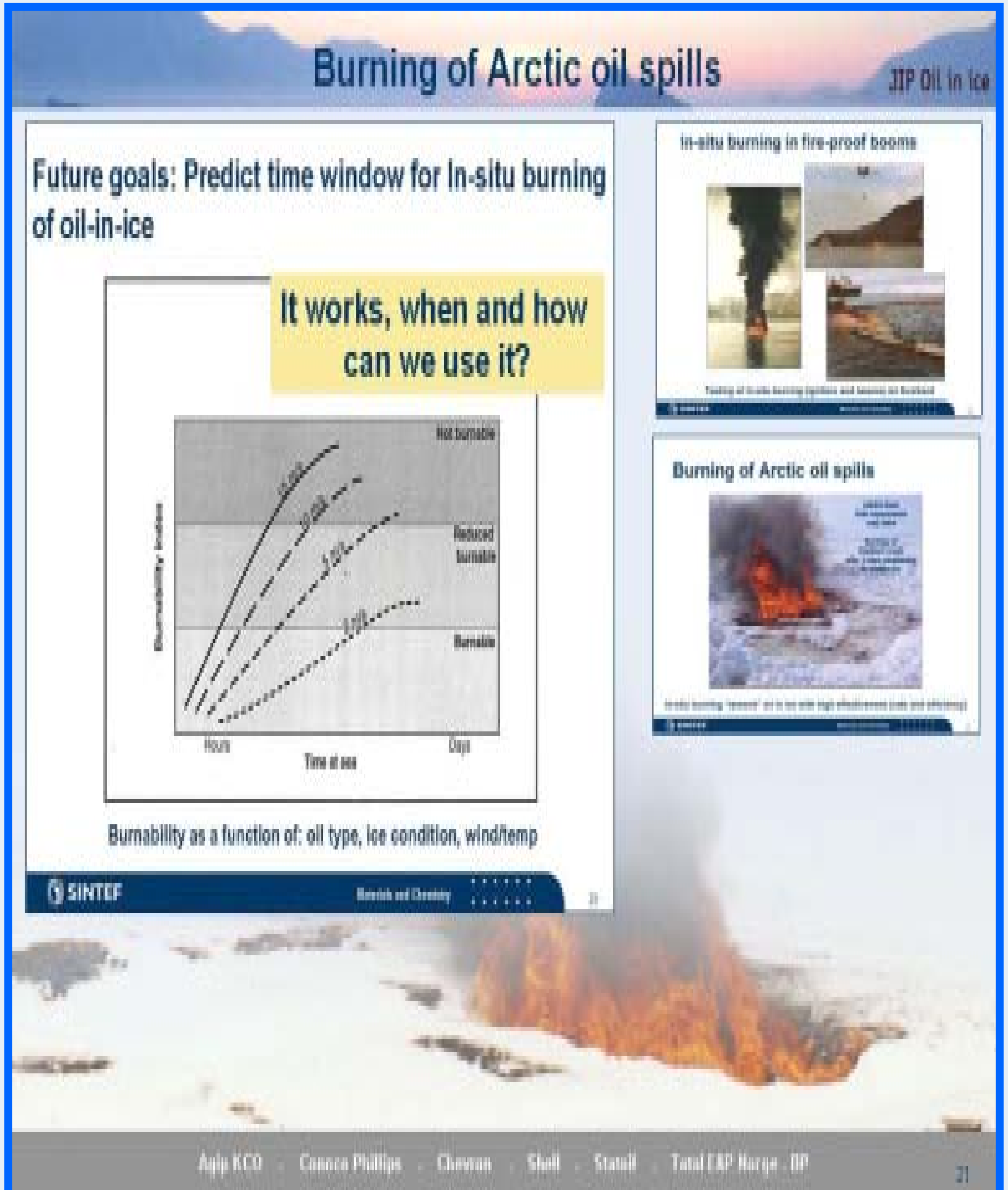
In situ burning

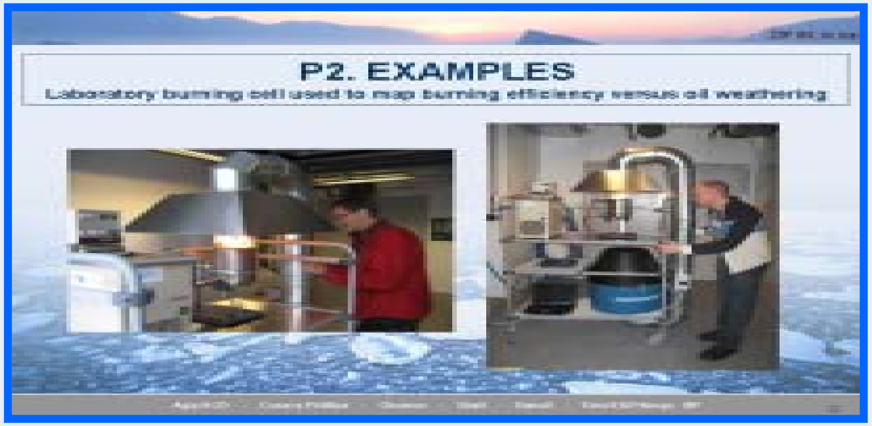
- In-situ burning is particularly suited for use in ice conditions, sometimes offering the only option for removal of surface oil.

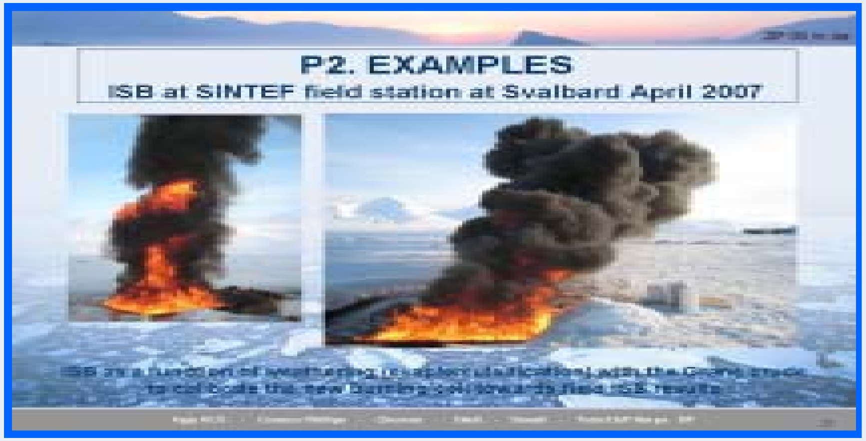
- Removal efficiency for thick slicks can exceed 90%. Oil removal rates of 2000 m3/hour can be achieved.

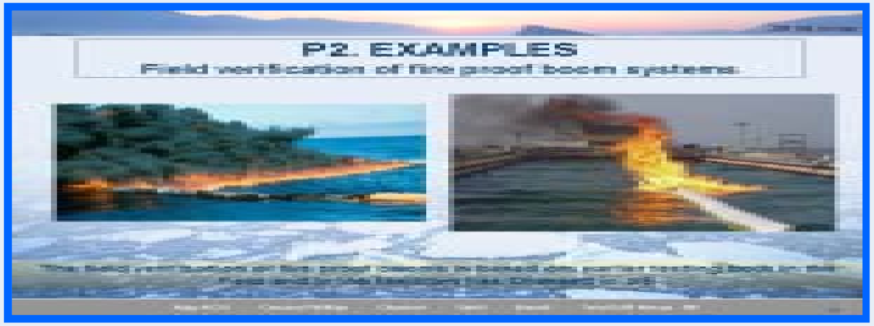
- The fundamentals of in-situ burning are;
  - Oil properties or oil type
  - Oil weathering (“window of opportunity”)
  - Environmental condition (especially wind and waves)
  - Safety hazards (human and the environment)
  - Oil availability for ignition/burning
  - Igniters
  - Fire-proof boom systems

P2 – In situ burning









Mechanical oil recovery

- Most ice-covered areas have ice-free seasons when technology developed for open waters can be used.

- Oil recovery operations in ice covered waters will however be confronted with totally different problems than in open waters;
  - Limited flow of oil to the recovery device
  - Limited access to the oil
  - Deflection of oil together with ice
  - Separation of oil from ice
  - Contamination of ice /cleaning of ice
  - Increased oil viscosity
  - Icing /freezing of equipment
  - Strength considerations
  - Detection of oil in various ice conditions

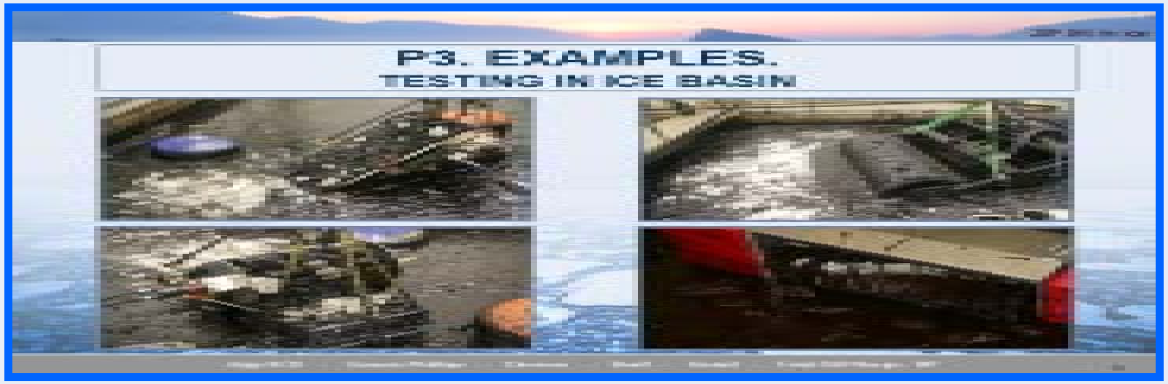
P3 - Mechanical recovery


MIZ-Experiment, Barents Sea, 1993

How can we make further improvements?

In cooperation with supliers of technology
from
Norway, Finland, Denmark


New lab at SINTEF 2007

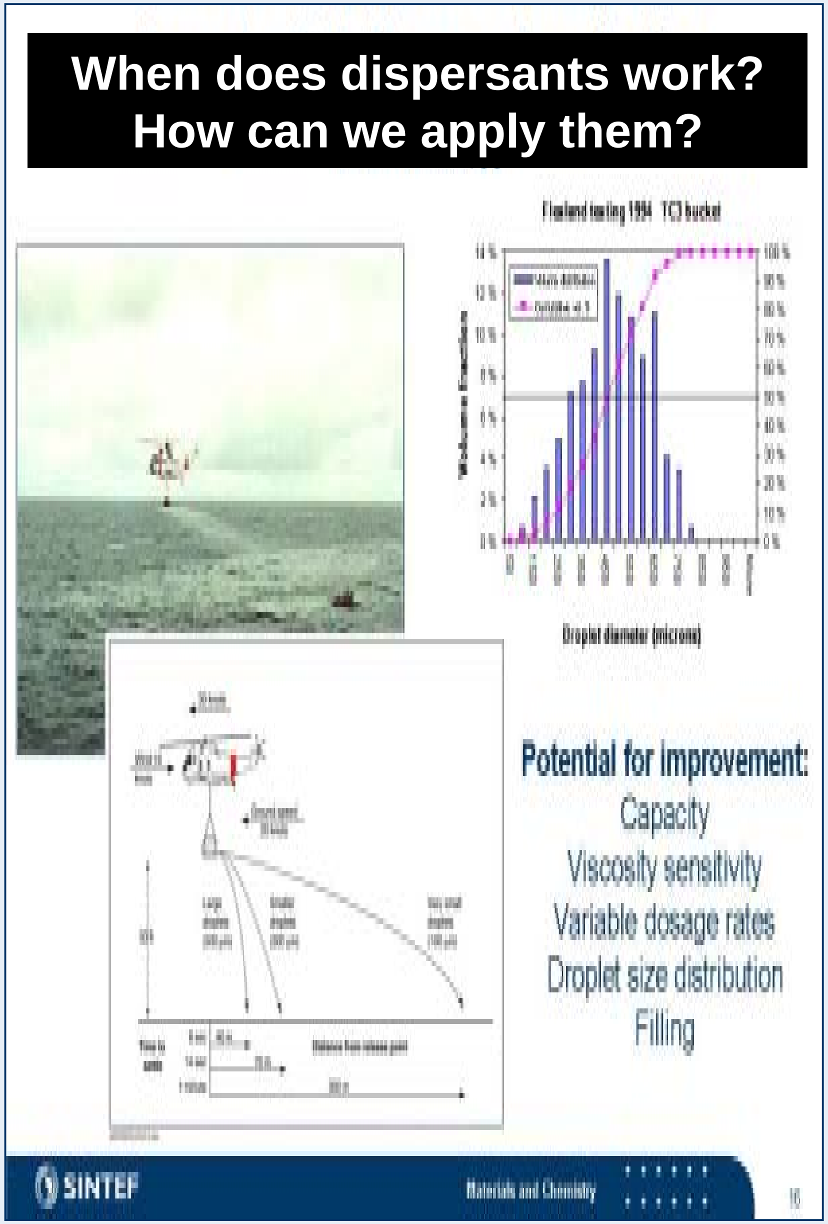


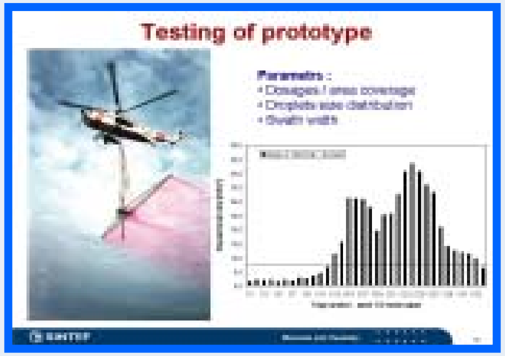
Dispersants

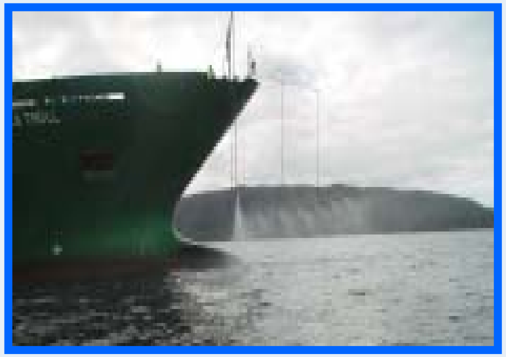
- Most of the studies with dispersants under "arctic" conditions have been performed through the Norwegian ONA-program (1990) and the DIWO-program (1993)..
- Later cold water dispersants studies have also been performed by S.L. Ross Environmental Research on Sakhalin/Hibernian/North Slope oils (S.L. Ross, 2001, 2002) and at SINTEF/CEDRE on North Sea crudes (2006).

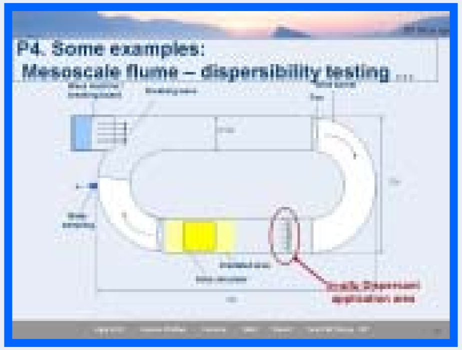
- The effectiveness of dispersants is dependent on:
  - Oil properties or oil type
  - Type of dispersant
  - Oil weathering (window of opportunity)
  - Sea water and air temperature (oil and dispersant properties)
  - Sea water salinity (surfactant leakage)
  - Energy conditions (to initiate chemical dispersion)
  - Oil availability for dispersant application

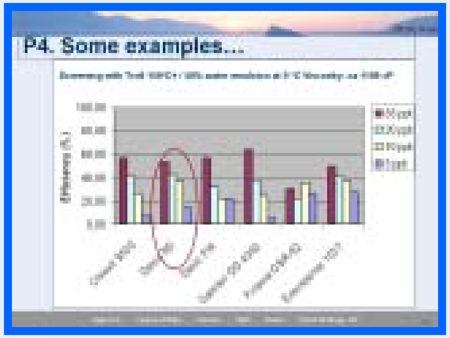
P4 - Dispersants











Monitoring and remote sensing

- When handling oil spills in open water we have a wide variety of remote sensing tools that can monitor the oil trajectory, the distribution of the oil and the film thickness of the oil on the sea surface.

- This is possible through a combination of sensors located onboard satellites, airplanes/helicopters and even operated from boats.

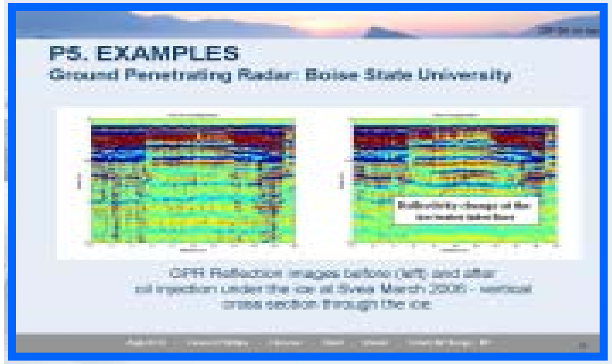
- **The question is;**
  - **Can we do the same with oil spills in ice?**

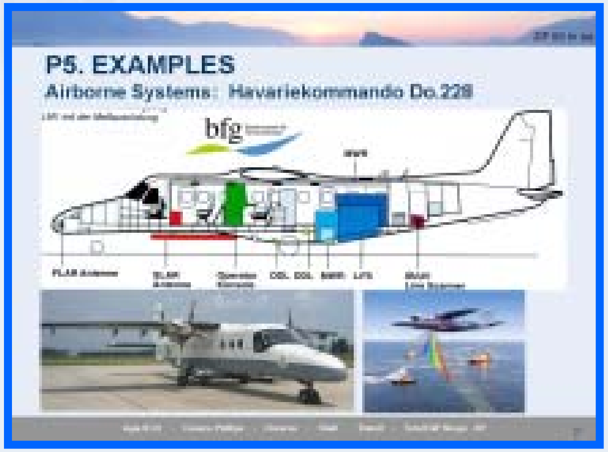
P5 – REMOTE SENSING

Experimental tech

Operational systems

To test and Document Experimental as well as operational systems Under realistic and Controlled Field conditions





P6 – P9

- **P6; Generic OSC Guide**
  - For planning purpose
  - Based on results from this program and previous work
  - On internet
- **P7; Coordination, managment**
  - Administration
  - Workshops (mainly internal)
  - Communication
- **P8. Field experiments**
  - At Svalbard
  - Offshore
- **P9; Biological effects**
  - Under development
  - In cooperation with CRRC

SOME IMPORTANT DELIVERABLES

MODELLING TOOLS:	**Oil weathering model**	**Upgrading of oil weathering algorithms** for a new version of SINTEF OWM.
TECHNOLOGY DEVELOPMENT	**Definition of "Window of opportunity"**	For **in-situ burning**
		For **use of chemical dispersants**
	New technology	For improved **mechanical recovery**
		For **dispersant application**
	Experience	through **meso-scale and full-scale field experiments**
	Documentation	of the usefulness for new as well as existing **remote sensing techniques**
	Tactical descriptions	For operational **use of chemical herders** on oil spilled in ice
		For the **use of fire proof booms and in situ burning** of oil spilled in ice
DECISION MAKING TOOL	**Generic Oil Spill Guide**	**Internet based generic oil spill contingency plan**
INFORMATION	**Publications and reports**	**5 publications** in relevant and international reviewed journals.
		Condensed **summary report and brochure**
	Work shops	**One WS pr semester**
		Final JIP oil-in-ice conference

Thank you for your attention